REMARKS

Claim Status

Applicants acknowledge, with appreciation, the indication that claims 5-9, 13 and 14 contain allowable subjected matter. Claims 1-19 are presented for examination, with claims 1, 10, 15, 16, 18 and 19 being in independent form. The Abstract of the Disclosure has been amended. Claims 1 and 15-19 have been amended, wherein claims 16, 18 and 19 have been placed into independent form. No new matter has been added. Reconsideration of the application, as amended, is respectfully requested.

Overview of the Office Action

The Abstract of the Disclosure has been objected to. Withdrawal of this objection is requested in view of the amendment to the Abstract shown above.

Claims 16-19 stand rejected under 35 U.S.C. §101 as directed to non-statutory subject matter.

Claims 1-4, 10-12 and 15 stand rejected under 35 U.S.C. §103(a) as unpatentable over U.S. Patent No. 5,768,307 ("*Schramm*") in view of U.S. Publication No. 2003/0054845 ("*Krasny*").

Applicants have carefully considered the Examiner's rejections and the comments provided in support thereof. For the following reasons, Applicants respectfully assert that all claims presented for examination in the present application are patentable over the cited references.

Amendments Addressing Section 112 Issues and Formalities

The Examiner has objected to the Abstract based on its length. In response to this objection, Applicants have amended the Abstract in a manner which is self-explanatory. Accordingly, withdrawal of this objection is appropriate.

Claim 15 stands objected to based on a minor informality. In response to the Examiner's objection, Applicants have incorporated the Examiner's suggested change in claim 15 in a self-explanatory manner. Withdrawal of this objection is in order.

Summary of the Subject Matter Disclosed in the Specification

The following descriptive details are based on the specification. They are provided only for the convenience of the Examiner as part of the discussion presented herein, and are not intended to argue limitations which are unclaimed.

A signal processing apparatus comprises a plurality of signal simulators for representing the effects on a received signal of a radio multipaths propagation channel, which is configured to provide reduced complexity in comparison to known, conventional simulators. Such a reduction in complexity is achieved by performing a transformation of a conventional representation of the channel having L paths and L correlation coefficients.

Each of the plurality of signal simulators generates a signal component value that is proportional to a complex zero mean Gaussian random variable having a pre-determined variance. The variance of each of the signal component values produced by each of the simulators is pre-determined by calculating the eigen values of a matrix formed from the correlation coefficients and from a channel correlation matrix which includes the average attenuation of each of the L paths (see pg. 3, lines 3-18 of the specification as originally filed).

Descriptive Summary of the Prior Art

Schramm discloses "methods and apparatus for demodulating a received communication signal employing coherent demodulation and decision-directed channel estimation that have a significant gain compared to a receiver employing noncoherent demodulation" (see Abstract). *Schramm* (col. 6, lines 48-51) teaches coherent receivers that do not require a pilot signal to operate and that use a decision-directed channel estimation scheme. According to *Schramm*, the disclosed coherent "receivers can be used in digital communication systems originally designed for noncoherent demodulation" (see col. 6, lines 51-53).

Krasny discloses methods for estimating the "time of arrival of a received signal with multipath components ... using an optimal algorithm, such as Maximum Likelihood Estimation (MLE), after restricting the optimal algorithm's search space to one or more time intervals determined by preprocessing the received signal using a less computationally complex sub-optimal algorithm". According to *Krasny*, "[s]ub-optimal algorithms include ... MUSIC, and Signal-Eigen-Vector (SEV) processing" (see Abstract).

Patentability of the Independent Claims Under 35 U.S.C. §101

The Examiner (pg. 2 of the Office Action) asserts that claims 16-19 are directed to non-statutory subject matter. In particular, the Examiner has stated that "[c]laims 16, 17, 18 and 19 recite a 'computer program' which does not impart functionality to a computer or computing device, and is thus considered nonfunctional descriptive material..." that "in the specification it is not clearly defined how the 'program' is stored in a tangible medium paragraph [63] ... claims 16, 17, and 19 define 'computer executable instructions' that ties with the 'computer program' which also encompasses non-statutory subject matter" and that claim 18 defines "'a data carrier' that ties with the 'computer program' which also encompasses non-statutory subject matter".

In response to the foregoing rejections, Applicants have amended claims 16, 17, 18 and 19 in a manner that is believed to address each specific rejection. For example, claim 16 has been placed into independent form and is now directed to an article of manufacture (e.g., recording medium) including a computer readable-medium adapted for use in a data processor of a signal processing. Claims 17-19 have been correspondingly amended.

In view of the foregoing, independent claims 16-19, as now amended, define a functional interrelationship with a computer, constitute a statutory process, machine or manufacture. These claims are, thus, directed to statutory subject matter. Accordingly, reconsideration and withdrawal of the rejections under 35 U.S.C. §101 are deemed to be in order, and notice to that effect is respectfully requested.

Patentability of the Claims Under 35 U.S.C. §103(a)

The Examiner contends (see pgs. 3-4 of the Office Action) that:

> Schramm et al. discloses a signal processing apparatus operable to represent the effects on a received signal of a radio communications channel having L paths (figure 6)
>
> . . .
>
> the signal processing apparatus comprising a plurality of signal simulators (figure 6) each simulator generating a signal component value proportional to a complex zero mean Guassian random variable having a pre- determined variance (column 11, lines 55-59)....

With respect to the foregoing, Applicants respectfully assert that *Schramm* fails to achieve the apparatus defined by amended independent claim 1, as well as the methods recited in independent claims 10 and 15, respectively.

Schramm discloses coherent demodulation receivers that do not require a pilot signal to operate and that use a decision-directed channel estimation scheme (see col. 6, lines 48-51). In contrast, amended independent claim 1 defines a signal processing apparatus that represents (i.e.,

simulates) the effects on a received signal of a radio communications channel having *L* paths. The apparatus disclosed in *Schramm* has no relation to Applicants' claimed simulator.

The Examiner asserts that the apparatus shown in FIG. 6 of *Schramm* is operable to represent the effects on a received signal of a channel. *Schramm* (col. 14, lines 46-51; FIG. 6) teaches that "temporary symbol estimate indexes $\tilde{m}'[\mu]$ are generated by noncoherent demodulation: square-law combining the correlation samples, which function is carried out by an SLC processor 58, and forming hard decisions of the combinations based on the decision rule $y'_{\tilde{m}'[\mu]} = \max_i y'_i[\mu]$, which function is carried out by slicer 60". *Schramm* (col. 6, lines 51-58) describes that "[e]ach temporary symbol estimates are used by a selector unit SEL for selecting the correlation samples $\tilde{x}_{m',\lambda}[\mu]$ that are fed into the respective channel estimation filter 52, which is represented in FIG. 6 by the impulse response $h_c[.]$. The output signal produced by each channel estimation filter 52 is the estimated weight $g_\lambda[.]$ of a respective propagation path λ, the complex conjugate of which is formed by a conjugator 62". Finally, *Schramm* (col. 6, lines 59-62) further describes that "the estimated path weight's complex conjugate $g_\lambda^*[.]$ is used in the maximum-ratio combining of the coherent demodulation ... which is carried out by MRC combiners 64". *Schramm* (FIG. 6) thus teaches the estimation of path weights.

In reviewing the Office Action, Applicants note that the Examiner has merely made a general reference to FIG. 6 of *Schramm* without providing any indication whatsoever of what portion of the disclosed apparatus constitutes Applicants' claimed plurality of signal simulators. Even assuming, *arguendo*, that by performing path weight estimations, the apparatus disclosed in FIG. 6 of *Schramm* achieves the function of representing effects on a received signal of a radio communications channel having *L* paths, the apparatus of FIG. 6 still fails to include "a plurality of signal simulators, each simulator generating a signal component value proportional to a complex zero mean Gaussian random variable having a pre-determined variance", as recited in

amended independent claim 1. *Schramm* also fails to teach or suggest the associated generating step recited in method claims 10 and 15, respectively.

Moreover, *Schramm* (col. 11, lines 55-59) fails to teach or suggest that each signal simulator generates a signal component value proportional to a complex zero mean Gaussian random variable having a pre-determined variance. The cited paragraph describes features associated with a rake receiver (see, e.g., col. 11, lines 33-34). In particular, *Schramm* (col. 11, lines 59-63) explains that the estimated path weight $\hat{g}_{\lambda}[.]$ is generated by feeding the correlation samples $x_{\hat{m}}$',λ[.] into a channel estimation filter 52, wherein the correlation samples $x_{\hat{m}}$',λ[.] are selected according to the temporary symbol estimates $\hat{m}'[\mu]$ by an estimation unit 56 and selector SEL for each path (see col. 11, lines 42-45). *Schramm* (col. 11, lines 50-55) further teaches that if a temporary symbol estimate is correct, $\hat{m}'[\mu]=m[\mu]$, then "the selected signal is given by the following expression: $x_{\hat{m}',\lambda}[\mu]=x_{m,\lambda}[\mu]=g_{\lambda}[\mu]+n_{m,\lambda}[\mu]$ in which $n_{m,\lambda}[\mu]$ represent the <u>noise</u> at the output of the correlators and are complex-valued, white, Gaussian processes with zero mean". *Schramm* thus clearly teaches an output comprising noise that is <u>white</u> and <u>Gaussian</u>, with zero mean.

However, there is no indication within the foregoing sections of *Schramm* with respect to a <u>plurality of simulators</u>, each of which generate a signal component value <u>proportional</u> to a complex zero mean Gaussian random variable having <u>a pre-determined variance</u>, as recited in amended independent claim 1. Without Applicants' claimed simulators, *Schramm* also fails to teach or suggest the associated generating step recited in method claims 10 and 15, respectively.

In addition, independent claim 1 recites "a summer operable to <u>sum</u> the signal component values produced from each signal simulator, to form a representation of the signal received via the radio communications channel, wherein the variance of each of the signal <u>component values</u>

produced by each of said plurality of signal simulators is pre-determined by calculating the eigen values of a matrix formed from the correlation coefficients and from a channel correlation matrix which includes the average attenuation of each of the L paths". *Schramm* fails to teach or suggest Applicants' claimed summer. Independent claims 10 and 15 recite a summing step which corresponds to the summer of independent claim 1. *Schramm* therefore also fails to teach or suggest the associated summing step of method claims 10 and 15, respectively.

The summer 64 of FIG. 6 sums the delayed correlation samples (54) weighted by $x_{m,\lambda}[\mu] \times \tilde{g}^*_{\lambda}[\mu]$ (see col. 10, line 62), which is a well known summation in accordance with maximum ratio combining (MRC). The result of the summation provides decision variables $y_i[.]$ (see FIG. 6). However, the output of the summer 64 is not a representation of the signal received via the radio communications channel but, rather, the output of the summer disclosed in FIG. 6 of *Schramm* is a representation of the emitted signal before transmission. *Schramm* therefore fails to teach or suggest the invention recited in independent claims 1, 10 and 15 for at least this additional reason.

The Examiner cites *Krasny* in an attempt to cure the shortcomings of *Schramm*, i.e., "the variance of each of the signal simulators is pre-determined by calculating the Eigen values of a matrix formed from correlation coefficients and a channel correlation matrix…". However, the combination of *Schramm* and *Krasny* fails to teach or suggest the limitations recited in amended independent claim 1, as well as the associated methods recited in independent claims 10 and 15.

Krasny (see paragraph [0017], lines 1-4) describes a sub-optimal algorithm to reduce or otherwise restrict the search space of an optimal algorithm used to precisely estimate the arrival time of a received signal". According to *Krasny*, "the method allows the algorithm to operate at fine time resolution without incurring impractical computational complexity" (see paragraph [0017], lines 13-15). However, *Krasny* is silent with respect to simulators generating a signal

component value proportional to a complex zero mean Gaussian random variable having a pre-determined variance or a summer to form a representation of the signal received via the radio communication channel. The combination of *Schramm* and *Krasny* therefore fails to achieve Applicants' claimed invention, as recited in amended independent claim 1, as well as the associated steps of method claims 10 and 15.

Moreover, the method described in *Krasny* relates to obtaining estimates of path delays τ_m (see paragraph [0026]). In contrast, the claimed invention relates to simulation of a radio communications channel, which is a field that is not closely related to the technology disclosed in *Krasny*. Thus, *Krasny* is from a non-analogous art. Therefore, the skilled person would have no reason to consider the teachings of *Krasny* when seeking to modify the apparatus of *Schramm* to achieve applicants claimed invention.

In accordance with the claimed invention, a new channel composed of new delays and new average powers per path is achieved. The new channel, which is less complex to simulate than the real channel, can be used to replace the real channel in any channel simulating apparatus. In a contrast, *Krasny* discloses a method for precisely estimating the delays of the real channel inside the receiver. *Krasny* thus teaches away from the claimed invention, since the processing is performed with respect to the real channel itself.

In addition, *Krasny* teaches the use of eigen values and eigen vectors of the estimated matrix $\hat{K}$ obtained by averaging the Q received copies of the received signal for reducing computational complexity. However, applying matrix diagonalization with the help of eigen values and eigen vectors is a mathematical technique that is old, well know and common. *Krasny* applies this method on an estimated K matrix that is obtained by averaging the Q received copies of the received signal (see paragraphs [0042] thru [0044]). In the present claimed invention, however, the inventive method is applied to the product matrix of the exact

channel matrix and a pulse shaping correlation matrix. Put differently, "the variance of <u>each</u> of the signal component values produced by each of said plurality of signal simulators is pre-determined by calculating the eigen values of a matrix formed from the correlation coefficients and from a channel correlation matrix which includes the average attenuation of each of the *L* paths". *Krasny* fails to teach or suggest this limitation. Therefore, the combination of *Schramm* and *Krasny* fails to achieve Applicants' claimed invention, since *Krasny* fails to provide what *Schramm* lacks.

In view of the foregoing, Applicants respectfully assert that the combination of *Schramm* and *Krasny* fails to render independent claims 1, 10 and 15 obvious and unpatentable. Therefore, reconsideration and withdrawal of the rejection under 35 U.S.C. §103 are in order, and a notice to that effect is earnestly solicited.

<u>Dependent Claims</u>

In view of the patentability of independent claims 1, 10, 15, 16, 18 and 19 for the reasons presented above, each of dependent claims 2-9, 11-14 and 17 is patentable over the prior art along with the independent claim from which it depends. Moreover, each of these claims includes features which serve to even more clearly distinguish the present invention over the applied references.

Conclusion

Based on all of the above, it is respectfully submitted that the present application is now in proper condition for allowance. Prompt and favorable action to this effect and early passing of this application to issue are respectfully solicited.

Should the Examiner have any comments, questions, suggestions or objections, the Examiner is respectfully requested to telephone the undersigned in order to facilitate reaching a resolution of any outstanding issues.

Respectfully submitted,
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